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ABSTRACT

Several influences upon mathemagenic activity during text learning were examined in this study, and the effects of attentional processes arising during instruction upon incidental rather than intentional learning were focused on. The subjects were 114 students enrolled in eight graduate classes in educational psychology. Six experimental groups were formed, and 19 subjects were randomly assigned to each group. The six experimental conditions consisted of programs with or without feedback prefaced by either advance organizers, instructional objectives, or a pretest. The subjects were tested with programed material to which had been added 21 incidental facts or names. The results indicated that the attention paid to incidental material was highest when feedback was absent. Reading instructional objectives, when feedback was absent, led to the greatest amount of incidental recall and a similar trend in other measures of incidental learning. (RR)

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# The Mathemagenic Effects of Feedback and Orienting Directions Upon Text Learning

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## A. Introduction

The present study examines several influences upon mathemagenic activity during text learning. As Rothkopf (13) defines it, mathemagenic activity involves student action that is relevant to the achievement of specified instructional objectives. It would appear that the study of mathemagenic activity necessitates a measure of learning often not directly relevant to stated objectives, ie, incidental learning.

> "Some investigators performed experiments in which the criterion test was derived from exactly the same material as the text question or in which the absence of transfer from the content underlying the experimental questions to the content underlying the criterion test was not experimentally established. It is difficult to interpret results from experiments such as these because it can not be determined to what extent criterion test performance reflects changes in mathemagenic activities or the direct instructive effects of questions." ( pg.333 ).

Thus, an assessment of concommitant incidental learning, during intentional learning, would allow a more unobtrusive and valid estimate to be made concerning the effects of instructional variables upon the processing of information.

Influences affecting mathemagenic activities seem to arise from two sources: those stimuli placed in the written text by the author and those found in the learner. Frase (9) delineated three boundary conditions for the attending and

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inspecting behaviors of a reader. Incentive, characteristics of the written text, and orienting directions all work together to influence both learning that is relevant and that is incidental to objectives internalized by the reader (9). Two influences upon mathemagenic activity are considered in this study: feedback following responses to text material and orienting directions prefacing the material. It has been theorized that orienting stimuli, whether in the text or in the reader, function by focusing the reader's attention on what is defined as important and by diverting that attention from merely incidental items. (6). Of interest to this study are three adjunct materials which direct a reader's attention while processing written text: instructional objectives, advance organizers, and a pre-test.

Ausubel (3) and Ausubel & Youssef (4) proposed that advance organizers mediate the learning of concepts or principles central to the meaning of written passages. Whether the organizing materials are introduced before or after the passage, the statement of concepts under which related ideas are subsumed improves either attention to or recall of the intentional items to be learned. Other studies of the effect of test-like events on both intentional and incidental learning from written materials (12:14) indicate the following. The position of questions affect attention variously: questions interspersed within and placed after a passage produce better recall of relevant and incidental information than those placed before materials to be read (8). Explicit instructional objectives have produced more relevant learning than mere exhortations to learn as much as possible (15). Also, instructional objectives read prior to a passage generally increase the learning of objective-relevant (10) and, contrary to the report of Duchastel (5), of incidental materials in a passage. Previous research apparently has not yet compared the relative influence of these three types of orienting materials on the same set of

stimuli. However, for the reasons noted previously, as suggested by Rothkopf, some measure of incidental learning would also appear necessary for such a comparison.

Immediate feedback for responses to text material has produced quite mixed results in the learning research literature. This seems partly attributable to the manner in which feedback is delivered. Research has found an absence of an effect, or even a negative effect, upon intentional performance when feedback is present (11;17). As Anderson (1) argues, this may be due to a "gross short-circuiting of attention when the correct answer is readily available" (pg.356). When control is maintained over feedback procedures, so that the feedback can be obtained only after a response is made, then intentional learning is facilitated (2). Frase (7) also supports this finding and additionally observed that incidental learning was not affected by the presence or absence of feedback. Since feedback usually contains information of an instructive nature upon which criterion tests are based, any attempt to assess the effects of feedback upon learning processes would also benefit from a measure of incidental learning. The inconsistency of previous investigations concerning the effects of feedback may be partly attributable to the failure to consider how the presence or absence of feedback actually influences learning, devoid of simple transfer effects. A positive effect or the absence of any effect of feedback upon intentional learning, when there is some transfer between feedback information and criterion test content, may be masking the actual attention given to the text. Thus, the effect of response feedback upon the attention given to textual material remains to be delineated.

Anderson (1) defines attention as the "processes whereby learners translate nominal stimuli into effective stimuli" (pg.349). In the present study the presence or absence of feedback and the types of orienting directions would

seem to be related directly to these processes. It has been maintained that attentional processes mediate both intentional and incidental learning. The focus of this study was on the effects of attentional processes, arising during instruction, upon incidental rather than intentional learning.

## B. Method

### 1. Subjects

The sample consisted of 114 students enrolled in eight graduate classes in educational psychology. Six experimental groups were established and 19 subjects were randomly assigned to each group.

### 2. Instrumentation

The basic instrument was formed by adding one incidental item to each of the 21 frames of a TMI-Grolier, Inc. program on "Wiring and Circuits." Four categories of items which could plausibly appear in such a program were selected: numbers of objects, names of people, materials used in the manufacture of electrical devices, and household electrical appliances. The 21 incidental items, in the form of one sentence fact statements (Ex: "Every year over 20,000 American homes catch fire due to electrical short circuits") were introduced into the frames of the program in varying sequences of the four categories.

Dependent Variables

The dependent variables were defined and measured as follows:

a) intentional frame performance - the number of correctly filled in responses to the frames. Two frames had multiple responses (range: 0-23).

b) incidental recall - the number of correctly recalled examples of the four categories of incidental elements on the post-program test. The test sheet which assessed this variable consisted of a description of each category and the actual number of these that

b) (continued) - had appeared in the program (five each, six for the category of numbers). Subjects were to list no more than this number for their answers (range: 0-21).

c) incidental recognition - the number of correctly recognized examples of the four categories. The test sheet, which followed the recall test, consisted of 15 examples listed under each of the four categories. Subjects were to circle the correct number of examples for each category (range: 0-21).

d) recognition of incidental facts - the number of correctly answered multiple choice questions involving the one sentence statements. Each question consisted of a stem, which was a partial restatement of an incidental fact and five alternate answers (range: 0-15).

e) reconstruction of incidental serial order - the number of points earned by correctly listing the order of introduction in the program of each example for each of the four categories, (first to be read, second, third, etc.) Two points were awarded if an example's exact order was given, one point if the answer was off one in either direction from its actual order of introduction (range: 0-42).

Feedback Procedures

Two versions of the program were formed. In one (Feedback) each frame was followed by the correct answer(s) and a cardboard mask was used to cover upcoming frames and answers. Half the subjects were randomly assigned this version and instructed in how to use the mask. The experimenters continuously monitored the subjects to discourage peeking or simply copying the answers. In the other version (No feedback) the frames and responses were identical but correct answers were absent.

Orienting Directions

Preceding either the Feedback or No-Feedback version was one of three types of orienting directions in the form of: Instructional Objectives, Advance Organizers, or Pre-Test. Each of these directions dealt with the intentional (originally programmed concepts of electricity) material only and did not involve any of the incidental items or facts added to the program. Corresponding examples of each are presented below.

Instructional Objectives: "The reader will be able to":

1. relate decreased resistance in a circuit with increased heat in the wiring.

Advance Organizers: "Read this; it should help you focus your attention on the main points of the program."

1. Short circuits in electrical wiring systems are caused by decreased resistance which:
   (a) allows increased rate of flow of current.
   (b) generates dangerous amounts of heat in a circuit.

Pre-Test: "This program on wiring is designed to teach you some concepts in electricity. To show you just how much you can learn, we are presenting a list of test questions which you are to answer.:

1. When resistance in a circuit is decreased:
   (a) heat builds up.
   (b) temperature decreases.

## 3. Procedure

The instructions, program, and tests of incidental learning were presented as a booklet to each subject. Subjects were prohibited from reviewing earlier pages of the booklet and a monitor (one of the experimenters) was always present. The statistical analyses used were: A two-way analysis of variance (Feedback x Orienting Direction) of intentional program frame performance;

a factorial multivariate analysis of variance (Feedback x Orienting Direction) of the four measures of incidental learning (likelihood ratio test). Post hoc comparison between means relied upon Tukey's HSD test.

D. Results and Discussion

The effects of the presence or absence of feedback and type of orienting directions upon performance are reflected in Table 1.

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Place Table 1 About here

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It can be seen that while neither experimental manipulation had any effect upon intentional frame performance, the absence of feedback had a positive effect upon levels of incidental learning. The analysis of variance of frame performance scores did not produce any significant effects. The multivariate analysis of variance of the four incidental learning measures produced the following values: Feedback ($F = 11.29$, $df = 4/105$) $p < .001$); Orienting Directions ($F = .581$, $df = 8/210$, ns.), Feedback x Orienting Direction ($F = 1.84$, $df = 8/210$, $p < .07$).

In order to explicate further the significant effect of Feedback upon incidental learning, univariate F tests were conducted for each measure. The alpha level for each test was set at .01, to allow rejection of the implied null hypothesis at $p < .05$ for each measure of incidental learning. Table 2 presents a summary of these tests, in addition to tests for the factor of Orienting Direction and the interaction of the two factors.

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Place Table 2 About here

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Feedback had consistently strong effects upon all four incidental variables. The multivariate F value for the interaction was not significant although the univariate F value for recall was significant.

Thus, neither factor of Feedback or Orienting Direction had an influence upon how well subjects completed their responses to each frame of the program. The absence of feedback did strongly relate to how many incidental items were correctly recalled or recognized, the number of multiple choice items of incidental facts correctly completed, and how well the serial order of presentation of incidental items was reconstructed. The simple effect of Orienting Direction was not significant for either frame performance or acquisition of incidental material. However the interaction of Feedback x Orienting Direction produced a significant effect for the variable of recall. Under the combined effect of the absence of feedback and the initial reading of instructional objectives, subjects recalled the greater number of incidental items, significantly more ($p < .01$) than any other of the five experimental conditions. Although significant interactions were not obtained for the other incidental learning variables, it should be noted that the combined effect of absence of feedback with instructional objectives always produced the largest mean of the six experimental conditions.

It is apparent that the intentional task of reading and making a response to each frame of the program was simplified to a degree that allowed most subjects in each condition to perform at near asymptotic levels. This could explain why neither experimental manipulation had an effect upon intentional performance, since a relatively low level of attention was demanded by the task. This does not imply that unused attentional capacity in a simple task cannot become functional. Indeed the significant increase in all measures of incidental learning under the nonfeedback conditions occurred without reduction in intentional performance. It is maintained that the increase in incidental learning is a result of added attentional processing of the material, ie, the mathemagenic effect of the absence of response feedback. This effect is consistent with the research that has found the presence of feedback to be a negative influence upon attention.

The data do not indicate that any one type of orienting direction decreased or increased the level of incidental learning. Again, this may be attributed to the simplicity of the intentional task as it reduced the likelihood that the various directions focused the subjects' attention on the intentional material and away from the incidental items. The interaction effect upon incidental recall, as well as a trend among the other incidental variables, is somewhat more difficult to explain. It may be that the specificity of objectives, in conjunction with the attentional demands acting when feedback is absent, produced the condition of greatest attention to the intentional task. Such a condition might also result in a higher level of incidental learning when the incidental material is well integrated with the intentional task (as in the present study) rather than being a competing task.

Thus, the present study would argue for positive mathemagenic effects in the absence of response feedback, particularly in a learning task that requires a moderate to low level of attention. Further study is necessary to define the effects of typical orienting instructions upon mathemagenic activity devoid of simple transfer value.

Table 1

Means and standard deviations of all dependent variables

for each experimental condition

| Condition | | Variable | | | | |
|---|---|---|---|---|---|---|
| | | Program Frame Performance | Recall | Recognition | Facts | Sequence |
| Feedback | | | | | | |
| Advanced Organizer | $\bar{X}$ | 20.32 | 6.42 | 12.21 | 9.21 | 19.32 |
| | SD | 2.00 | 2.11 | 3.70 | 2.76 | 6.52 |
| Instructional Objective | $\bar{X}$ | 20.00 | 5.90 | 11.42 | 9.26 | 16.79 |
| | SD | 1.80 | 1.70 | 2.65 | 2.81 | 4.60 |
| Pre-Test | $\bar{X}$ | 20.00 | 6.63 | 11.68 | 9.47 | 19.42 |
| | SD | 2.47 | 1.54 | 2.73 | 1.93 | 6.25 |
| No Feedback | | | | | | |
| Advance Organizer | $\bar{X}$ | 20.72 | 7.37 | 12.63 | 10.95 | 21.26 |
| | SD | 1.49 | 1.86 | 1.70 | 1.22 | 4.32 |
| Instructional Objective | $\bar{X}$ | 20.02 | 9.63 | 14.11 | 11.37 | 22.74 |
| | SD | 1.7° | 1.80 | 2.05 | 1.38 | 3.60 |
| Pre-Test | $\bar{X}$ | 19.98 | 7.53 | 13.05 | 10.78 | 21.05 |
| | SD | 1.73 | 1.81 | 2.48 | 1.47 | 4.64 |

Table 2

Results of the univariate F tests of the effects of feedback and orienting directions upon incidental learning

| | Source | | | | | |
|---|---|---|---|---|---|---|
| | Feedback | | Orienting Direction | | Interaction | |
| Variable | MS | F | MS | F | MS | F |
| Recall | 98.56 | 30.03* | 7.96 | 2.42 | 25.11 | 7.65* |
| Recognition | 63.38 | 9.41* | 1.75 | .26 | 12.27 | 1.82 |
| Facts | 84.25 | 20.40* | .59 | .14 | 1.48 | .36 |
| Serial Order | 287.38 | 11.07* | 21.69 | .84 | 23.48 | 1.90 |

Note:

* $p < .01$

References


1. Anderson, R. C. Control of student mediating processes during verbal learning and instruction. Review of Educational Research, 1970, 40, 349-369.

2. Anderson, R. C., Kulhavey, R. W. & Andre, T. Conditions under which feedback facilitates learning from programmed lessons. Journal of Educational Psychology, 1972, 63, 186-188.

3. Ausubel, D. The use of advance organizers in the learning and retention of meaningful verbal material. Journal of Educational Psychology, 1960, 54, 267-272.

4. Ausuble, D. & Youssef, M. The role of discriminability in meaningful parallel learning. Journal of Educational Psychology, 1963, 54, 331-336.

5. Duchastel, P. Incidental and relevant learning with instructional objectives. (Technical Memo 66) Tallahasse: Florida State University. Computer-Assisted Instruction Center, 1972.

6. Duchastel, P., & Brown, B. Incidental and relevant learning with instructional objectives. Journal of Educational Psychology, 1974, 66, 4, 481-485.

7. Frase, L. T. Learning from prose material: length of passage, knowledge of results, and position of questions. Journal of Educational Psychology, 1967, 58, 266-272.

8. Frase, L.T Effect of question location, pacing, and mode upon retention of prose material. Journal of Educational Psychology, 1968, 59, 244-249.

9. Frase, L. T. Boundary conditions for mathemagenic behaviors. Review of Educational Research, 1970, 40, 3, 337-348.

10. Kaplan, R., & Rothkopf, E. Instructional objectives as directions to learners: effect of passage length and amount of objective - relevant content. Journal of Educational Psychology, 1974, 66, 3, 448-456.

11. Lublin, S. C. Reinforcement schedules, scholastic aptitude, autonomy need, and achievement in a programmed course. Journal of Educational Psychology, 1965, 56, 295-302.

12. Rothkopf, E. Z. Learning from written instructive material: an exploration of the control of inspection behavior by test-like events. American Educational Research Journal, 1966, 3, 241-249.

13. Rothkipf, E. The concept of mathemagenic activities. Review of Educational Research, 1970, 40, 3, 325-336.

14. Rothkopf, E. & Bisbicos, E. Selective facilitative effects of interspersed questions on learning from written material. Journal of Educational Psychology, 1967, 58, 56-61.

15. Rothkopf, E., & Kaplan, R. An exploration of the effect of density and specificity of instructional objectives on learning from text. Journal of Educational Psychology, 1972, 63, 295-302.